NON-PUBLIC?: N
ACCESSION #: 9112030305
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Palo Verde Unit 1 PAGE: 1 OF 10

DOCKET NUMBER: 05000528

TITLE: Unit 1 and Unit 3 Reactor Trips Caused by Grid Perturbation
EVENT DATE: 10/27/91 LER #: 91-010-00 REPORT DATE: 11/26/91

OTHER FACILITIES INVOLVED: Palo Verde Unit 3 DOCKET NO: 05000530

OPERATING MODE: 1 POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(iv)
OTHER - Special Report

LICENSEE CONTACT FOR THIS LER:
NAME: Thomas R. Bradish, Compliance TELEPHONE: (602) 393-2521
Manager

COMPONENT FAILURE DESCRIPTION:
CAUSE: SYSTEM: COMPONENT: MANUFACTURER:
REPORTABLE NPRDS:

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT:

On October 27, 1991, at approximately 0722 MST, Palo Verde Units 1 and 3 were operating at approximately 100 percent power when a grid perturbation caused the Main Turbine Control System to fast close and immediately reopen the turbine control valves (TVCs). The momentary reduction in steam flow caused the steam bypass control valves in Units 1 and 3 to quick open. A reactor power cutback occurred in Unit 3, but not in Unit 1. Reactor trips in Units 1 and 3 occurred when reactor power exceeded the Core Protection Calculator Variable Overpower Trip setpoints. Immediately following the trips, Safety Injection Actuation System (SIAS) and Containment Isolation Actuation System (CIAS) Engineered Safety Feature Actuation System actuations occurred on low pressurizer pressure. All safety system components actuated as designed in each unit. By approximately 0805 MST on October 27, 1991, the plants were stabilized in Mode 3 (HOT STANDBY).

The cause of the event was determined to be.the expected plant response to a unique combination of circumstances. The event was precipitated by a grid fault resulting from a lightning strike on a substation feeder line. The fault which occurred was different from previous grid disturbance events (i.e., fault without ground). The generator output current at Palo Verde decreased triggering a momentary Power/Load Unbalance turbine protection actuation. This submittal also provides a Special Report in accordance with Technical Specification 3.5.2 ACTION b.

END OF ABSTRACT

I. DESCRIPTION OF WHAT OCCURRED:

A. Initial Conditions:

At 0722 MST on October 27, 1991, Palo Verde Units 1 and 3 were operating at approximately 100 percent power in Mode 1 (POWER OPERATION). Palo Verde Unit 2 was in MODE 6 (REFUELING) i
a
refueling outage and was not adversely affected by the event described in Section I.B below.

B. Reportable Event Description (Including Dates and Approximate Times of Major Occurrences):

Event Classification: An event that resulted in automatic actuation of an Engineered Safety Feature (ESF) (JE) and the Reactor Protection System (RPS) (JC).

On October 27, 1991, at approximately 0722 MST, Palo Verde Units 1 and 3 were operating at approximately 100 percent power when a grid perturbation caused the Main Turbine Control System (JJ) (TCS) to fast close and immediately reopen the turbine control valves (TCVs) (FCV)(TA). The momentary reduction in steam flow caused steam bypass control valves (V) (JI) in Units 1 and 3 to quick open. A reactor power cutback (RPCB) (JD) occurred in Unit 3, but not in Unit 1. Reactor (RCT)(AC) trips in Units 1 and 3 occurred when reactor power increased above the Core Protection Calculator Variable Overpower Trip (CPC VOPT) (JC) (JE) setpoints. Immediately following the reactor trips, valid actuations of the Safety Injection Actuation System (SIAS) (BP/BQ) and the Containment Isolation Actuation

System (CIAS) (JM) Engineered Safety Features Actuation System (ESFAS) (JE) occurred in each unit due to low pressurizer (AB) pressure. By approximately 0755 MST on October 27, 1991, the SIAS and CIAS actuations were reset in each unit. All safety system components actuated as designed in each unit. The plants were stabilized in Mode 3 (HOT STANDBY).

Prior to the reactor trips, at approximately 0721 MST, Unit 1 and Unit 3 Control Room (NA) personnel (utility, licensed) reported that the lights in the Control Rooms flickered. In addition, station personnel (utility and contractor, non-licensed) reported local lightning strikes. However, the local lightning strikes could not be confirmed by physical damage or monitoring instrumentation. Numerous electrical system alarms (Alm)(IB) were received by both units. The control boards (CBD)(IB) in Units 1 and 3 indicated that main turbine/main generator (TA/TB) large

load fluctuations were in progress. The Main Turbine Electro Hydraulic Control System (EHC) (TG) Power/Load Unbalance (PLUB) (JJ) protection circuitry sensed a mismatch between the turbine power and the generator power and initiated a turbine control valve (TCV) fast closure, closing two of the four Tcvs in Unit 1 and all four TCVs in Unit 3. (Note: See Section I.I for a system description.) The Steam Bypass Control System (JI) in Units 1 and 3 responded as designed to the reduction in steam flow (i.e., TCV closures) in order to control the secondary pressure. The in-service (i.e., seven of eight) steam bypass control valves (SBCVs) quick opened as designed. A reactor power cutback (RPCB) occurred in Unit 3 when the change in steam flow exceeded the RPCB setpoint of 55 percent. The reduction in steam flow in Unit 1 was not of the same magnitude as the steam flow reduction in Unit 3 (i.e., only two of the four TCVs closed in Unit 1). Therefore, the change in steam flow did not exceed the RPCB setpoint and Unit 1 did not experience an RPCB prior to the reactor trip. When the PLUB condition cleared (in approximately two cycles or 0.03 seconds), the TCVs rapidly reopened. The modulation of the SBCVs, combined with the reopening of the TCVs when the PLUB actuation cleared, resulted in an excess steam demand causing primary system temperature to decrease and reactor power to increase in each unit. The reactor power increase was terminated by Core Protection Calculator (CPC) generated auxiliary trip signals on Variable Overpower (rate of change in

power). This resulted in reactor trips and subsequent main turbine/main generator trips in each unit. The reactor power levels recorded just prior to the trip were approximately 104 percent in Unit 1 and approximately 88 percent in Unit 3.

The combination of the modulating SBCVs and the open TCVs also caused primary system temperature to decrease resulting in a pressure decrease below the low pressurizer pressure setpoint of 1837 pounds per square inch absolute (psia). Valid actuations of SIAS and CIAS occurred in each unit due to low pressurizer pressure.

In Unit 1, pressurizer pressure decreased to a minimum value of approximately 1782 psia, while level decreased to approximately ten (10) percent with pressurizer heater cutout occurring at approximately 25 percent, as designed. A review of data acquired from the plant monitoring system (IQ) indicated that the SIAS and CIAS occurred 21 seconds after the reactor trip. Primary system pressure recovered to approximately 2250 psia by a combination of pressurizer heater reenergization, reduction of steam flow (i.e., turbine trip), and safety injection flow. Pressurizer pressure decreased below the discharge head of the safety injection pumps

resulting in the injection of borated water into the reactor coolant system (RCS) (AB).

In Unit 3, pressurizer pressure decreased to a minimum value of approximately 1837 psia, while level decreased to approximately fifteen (15) percent with pressurizer heater cutout occurring at approximately 25 percent, as designed. A review of data acquired from the plant monitoring system indicated that the SIAS and CIAS occurred 18 seconds after the reactor trip. Primary system pressure recovered to approximately 2250 psia by a combination of pressurizer heater reenergization and reduction of steam flow (i.e., turbine trip). Pressurizer pressure remained above the discharge head of the safety injection pumps, therefore, borated water was not injected into the RCS.

At approximately 0729 MST on October 27, 1991, each unit declared an Unusual Event. The Unusual Events were declared pursuant to the Emergency Plan Implementing Procedure (EPIP-02) for an event resulting in Safety Injection Actuation System

(SIAS) actuations caused by a valid low pressurizer pressure.

By approximately 0755 MST on October 27, 1991, the SIAS and CIAS actuations were reset in each unit. By approximately 0805 MST, Control Room personnel in each unit stopped Trains A and B Containment Spray pumps (P) (BE), High Pressure Safety Injection pumps (P) (BQ), and Low Pressure Safety Injection pumps (P) (BP). All safety system components actuated as designed. The plants were stabilized in Mode 3 (HOT STANDBY). At approximately 0905 MST on October 27, 1991, the Unusual Events were terminated in accordance with EPIP-03.

C. Status of structures, systems, or components that were inoperable at the start of the event that contributed to the event:

Not applicable - no structures, systems, or components were inoperable at the start of the event which contributed to this event.

D. Cause of each component or system failure, if known:

Not applicable - no component or system failures were involved.

E. Failure mode, mechanism, and effect of each failed component, if known:

Not applicable - no component failures were involved.

F. For failures of components with multiple functions, list of systems or secondary functions that were also affected:

Not applicable - no failures of components with multiple functions were involved.

G. For a failure that rendered a train of a safety system inoperable, estimated time elapsed from the discovery of the failure until the train was returned to service:

Not applicable - no failures that rendered a train of a safety system inoperable were involved.

H. Method of discovery of each component or system failure or procedural error:

Not applicable - there have been no component or system failures or procedural errors identified. There were no procedural errors which contributed to this event.

I. Cause of Event:

An investigation of this event was conducted in accordance with the APS Incident Investigation Program. As part of the investigation, APS Engineering personnel (utility, non-licensed) determined that the event was set up by a unique combination of circumstances.

The event was precipitated by a grid fault (i.e., a simultaneous three phase fault without ground) resulting from a lightning strike on the 230 kV Anderson/South Phoenix substation feeder line. The fault which occurred was different from previous grid disturbance events (i.e., fault without ground). The grid voltage dropped momentarily to approximately 401 kV from 525 kV, triggering the Palo Verde Units 1 and 3 Digital Fault Recorders (XR)(TB) which captured the event.

The Palo Verde main turbines are equipped with an Electro Hydraulic Control System (EHC) Power/Load Unbalance (PLUB) protection circuitry as a turbine trip anticipator for turbine overspeed protection. The PLUB monitors for mismatch between the turbine power (as indicated by intermediate stage pressure) and generator power (as indicated by generator output current). A PLUB actuation is generated by a forty (40) percent decrease in generator output current within 35 milliseconds without a change in turbine intermediate stage pressure. Normally when a PLUB actuation is received, the turbine control valves (TCVs) close,

the combined intercept valves (CIVs) (V)(TA) close, and a PLUB annunciation is indicated on the first hit panel of the Turbine Supervisory Instrumentation (JJ) in the Control Room. If the PLUB condition clears (e.g., the load returns), the TCVs and CIVs reopen.

As part of the investigation, a rectified
enerator output
current profile was constructed for Palo Verde Unit 3. This is a graphical representation of the current signal monitored by

the PLUB. A review of the profile showed that the first drop in current exhibited the required forty (40) percent decrease in generator output current in approximately three (3) milliseconds, thereby meeting the requirements for PLUB initiation. In Unit 3, the PLUB logic closed all four (4) TCVs. However, because the initiating event was a grid fault and not a load rejection, the generator output current decrease was only momentary. The PLUB cleared (in approximately two cycles or 0.03 seconds) and the TCVs reopened. The duration of the PLUB condition was not sufficient for the relay to actuate CIV closure or to indicate the PLUB annunciation on the first hit panel of the Turbine Supervisory Instrumentation.

The response in Palo Verde Unit 1 to the grid fault was virtually identical. However, the relay timing was more critical in Unit 1 in that the duration of the PLUB condition was not sufficient to actuate a closure of all four (4) TCVs. Only two (2) TCVs closed. As occurred in Unit 3, the CIVs in Unit 1 did not close nor was the PLUB annunciation indicated on the first hit panel of the Turbine Supervisory Instrumentation.

The analysis of the event and the timing aspects of the relay response were confirmed through discussions with the main generator vendor (General Electric). Therefore, the cause of the TCVs' closure was the expected plant response to a PLUB actuation (SALP Cause Code C: External Cause).

The Steam Bypass Control System responded as designed to the reduction in steam flow (i.e., TCV closures) with a quick open signal to the steam bypass control valves (SBCVs) in order to control secondary pressure. The opening of the SBCVs, combined with the reopening of the TCVs when the PLUB condition cleared, resulted in an excess steam demand causing primary system temperature to decrease and reactor power to increase. The resulting reactor power increase in both units was terminated by a Core Protection Calculator generated auxiliary trip signal on Variable Overpower. This resulted in reactor trips and subsequent main turbine/main generator trips as described in Section I.B.

As stated above, because the initiating event was a grid fault and not a load rejection, the generator output current decrease was only momentary. The opening of the SBCVs, combined with the reopening of the TCVs when the PLUB condition cleared,

resulted in a reactor power transient and subsequent reactor trip (SALP Cause Code C: External Cause).

As discussed in Section I.B, the combination of the modulating SBCVs and the reopened TCVs caused primary system temperature to decrease resulting in a pressure decrease below the low pressurizer pressure setpoint of 1837 psia. A valid actuation of SIAS and CIAS occurred in each unit due to low pressurizer pressure.

As stated above, because the initiating event was a grid fault and not a load rejection, the generator output current decrease was only momentary. The opening of the SBCVs, combined with the reopening of the TCVs when the PLUB condition cleared, resulted in a primary system temperature transient resulting in low pressurizer pressure and subsequent SIAS and CIAS (SALP Cause Code C: External Cause).

No unusual characteristics of the work location (e.g., noise, heat, poor lighting) directly contributed to this event. There were no procedural errors which contributed to this event. There were no personnel errors which contributed to this event.

J. Safety System Response:

The following Unit 1 and Unit 3 safety systems actuated automatically as a result of the event:

- Emergency Diesel Generators (EK), Trains A and B,
- Essential Spray Pond Systems (BS), Trains A and B,
- Essential Chilled Water System (KM), Trains A and B,
- Essential Cooling Water System (BI), Trains A and B,
- High Pressure Safety Injection (BQ), Trains A and B,
- Low Pressure Safety Injection (BP), Trains A and B,
- Containment Spray System (BE), Trains A and B,
- Control Room Essential Heating, Ventilation and Air Conditioning (HVAC) System (AHU), Trains A and B,
- Control Room Essential Ventilation System (AHU), Trains A and B,
- Essential Auxiliary Feedwater System (BA), Trains A and B, and
- Containment Isolation System (JM).

K. Failed Component Information:

Not applicable - no component failures were involved.

II. ASSESSMENT OF THE SAFETY CONSEQUENCES AND IMPLICATIONS OF THIS
EVENT:

A safety limit evaluation was performed as part of the APS Incident Investigation. The evaluation determined that the plant responded as designed, that no safety limits were exceeded, and that the event was bounded by current safety analyses.

The event reported by this LER (528/91-010) is bounded by the Palo Verde Updated Final Safety Analysis Report (FSAR) Chapter 15 accident scenarios concerning increases in heat removal by the secondary system and a previous analysis for opening of all eight steam bypass control valves Letter from W. F. Conway, APS, to J. B. Martin, USNRC, (161- 03569-WFC/MEP/RAB) dated November 1, 1990!. In addition, the Updated FSAR Chapter 6 scenarios concerning loss of coolant accidents were not challenged by this event,

The impact of the transients (i.e., depressurization, concurrent decrease in primary system temperature and pressurizer level) posed no threat to fuel integrity as adequate subcooling margin and reactor coolant system (RCS) inventory were maintained throughout the event. The maximum RCS pressure recorded during the event was 2268 psia in Unit 1 and 2290 psia in Unit 3, which did not exceed the 2750 psia safety limit.

The event did not result in any challenges to the fission product barriers or result in any releases of radioactive materials. Therefore, there were no safety consequences or implications as a result of this event. This event did not adversely affect the safe operation of the plant or health and safety of the public,

III. CORRECTIVE ACTION:

A. Immediate:

An investigation team was formed and an investigation was initiated in accordance with the APS Incident Investigation Program. As part of the investigation, APS Engineering initiated a root cause investigation.

B. Action to Prevent Recurrence:

A temporary modification (TMOD) to the Main Turbine Electro Hydraulic Control System (EHC) Power/Load Unbalance (PLUB) protective circuitry was installed in both Units 1 and 3 prior to synchronization on the grid. In the event of an occurrence of a PLUB protection circuitry actuation, the TMOD added a turbine trip signal in parallel with the automatic fast closure signal to the turbine control valves (TCVs) and the combined intercept valves (CIVs). Additionally, an input was added to the Digital Fault Recorder to provide a record of the PLUB signal. The TMOD eliminates the possibility that the TCVs will reopen by actuating a turbine trip signal, thereby eliminating a contention problem between two steam control systems (i.e., SBCS and TCVs).

In addition, APS is investigating the possibility of a permanent design change that will enhance the detection capabilities of the PLUB protection circuitry (i.e, distinguish a grid fault from a load rejection). The appropriate actions to preclude the event occurring in Unit 2 will be installed prior to Unit 2 returning to power from their refueling outage (i.e., TMOD or alternate design change). APS is also performing a Turbine Control System evaluation. If substantial information is developed which would significantly alter the readers' understanding or perception of this event, a supplement to this report will be submitted.

IV. PREVIOUS SIMILAR EVENTS:

No other previous events have been reported pursuant to 10CFR50.73 where a grid perturbation and subsequent main turbine/main generator large load fluctuations caused a momentary Power/Load Unbalance (PLUB) which ultimately resulted in simultaneous reactor trips.

As reported previously in LER 528/86-002, on August 6, 1986, simultaneous reactor trips occurred in both Palo Verde Units 1 and 2 when the startup transformer NAN-X03 shed its Unit 1 and Unit 2 loads due to a faulty current transformer. As a result, two (2) reactor coolant pumps (P)(AB) in each unit tripped causing the low flow projected Departure from Nucleate Boiling Ratio (DNBR) trip signals from their respective Core Protection Calculators (CPC). As corrective action, the faulty transformer was replaced. The cause for the simultaneous reactor trips was different than the event reported by this LER (528/91-010). Therefore, the corrective actions for the previous event would not have prevented this event.

As reported previously in LER 528/86-056, on October 6, 1986, Palo Verde Unit 1 tripped when a load rejection event occurred due to the main generator output breakers opening. The loss of generator load resulted in a Power/Load Unbalance (PLUB) which closed the main turbine control valves (TCVs) and combined intercept valves (CIVs). A reactor power cutback (RPCB) and a Steam Bypass Control System actuation occurred. The turbine was manually tripped. The reactor subsequently tripped due to problems with feedwater level control. The PLUB condition remained, therefore, the TCVs and the CIVs remained closed during the period that the SBCVs were open. As corrective action for problems with the feedwater level control, troubleshooting of the economizer valve (V)(AB) was conducted. The cause of the reactor trip was different than the event reported by this LER (528/91-010). Therefo
e, the corrective actions for the
previous event would not have prevented this event.

V. ADDITIONAL INFORMATION:

Based on reviews by the Plant Review Board, the Management Response Teem and the Incident Investigation Team, unit restarts were authorized by the respective Plant Managers in accordance with approved procedures. Unit 3 entered Mode 2 (STARTUP) at approximately 1604 MST on October 30, 1991, and was synchronized on the grid at approximately 0728 MST on October 31, 1991. Unit 1 entered Mode 2 at approximately 0444 MST on October 31, 1991, and was synchronized on the grid at approximately 1631 MST on October 31, 1991.

VI. SPECIAL REPORT:

In Palo Verde Unit 1, there have been 6 total accumulated actuation cycles of the Emergency Core Cooling System to date. In Palo Verde Unit 3, there have been 2 total accumulated actuation cycles of the Emergency Core Cooling System to date. This satisfies the requirements of Technical Specification 3.5.2 ACTION b.

Arizona Public Service Company
PALO VERDE NUCLEAR GENERATING STATION
P.O. BOX 52034 o PHOENIX, ARIZONA 85072-2034

JAMES M. LEVINE 192-00756-JML/TRB/KR
VICE PRESIDENT November 26, 1991
NUCLEAR PRODUCTION

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Mail Station P1-37
Washington, D.C. 20555

Dear Sirs:

Subject: Palo Verde Nuclear Generating Station (PVNGS)
Unit 1
Docket No. STN 50-528 (License No. NPF-41)
Licensee Event Report 91-010-00
File: 91-020-404

Attached please find Licensee Event Report (LER) 91-010-00 prepared and submitted pursuant to 10CFR50.73. In accordance with 10CFR50.73(d), we are forwarding a copy of the LER to the Regional Administrator of the Region V office.

If you have any questions, please contact Thomas R. Bradish, Compliance Manager, at (602) 393-2521.

Very truly yours,

JML/TRB/KR/nk

Attachment

cc: W. F. Conway (all with attachment)
J. B. Martin
D. H. Coe
INPO Records Center

*** END OF DOCUMENT ***